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DEVELOPMENTAL TESTS OF SYNTHETIC ORGANIC COMPOUNDS AS INSECTICIDES. PART I

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In two previous papers (E-621, 1944; E-634, 1945) the authors summarized the results of certain preliminary insecticide tests conducted on 979 synthetic organic compounds. The tests were made on 20 species of insects at the insecticide-testing laboratory of the Bureau of Entomology and Plant Quarantine at Sanford, Fla. Those tests were all designed to furnish preliminary evidence of toxicity in new samples and to determine which insect pests were susceptible. Of these compounds 213 were found sufficiently effective to be worthy of further investigation. These compounds were therefore subjected to additional tests in the laboratory for further screening to select materials for field tests. The nonvolatile materials were tested in screen cages to determine their value as possible stomach insecticides, and the volatile compounds were tested for their fumigating effect. Inasmuch as a positive test as a stomach poison or a fumigant does not necessarily preclude the possibility of contact action, all the compounds that were effective in these tests were scheduled for testing as contact insecticides. As yet, however, only a few compounds have been tested, and the method has not been perfected. Most of the methods employed have been described by Swingle, Phillips, and Gahan (8).

Since the establishing of evidence of stomach or contact action must be followed by tests on the tolerance of plant foliage to the insecticides before any decision can be made as to the possibilities of the new materials, phytotoxicity tests were also made on 35 of the compounds.

Most of the compounds tested and reported in this paper were received from the Division of Insecticide Investigations, and some of them have been patented as insecticides by members of that Division. A few additional compounds were purchased by the Division of Control Investigations. More often than not, the compounds were received in

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1/ M. C. Swingle resigned December 18, 1943, J. B. Gahan was transferred to the Division of Insects Affecting Man and Animals February 1, 1943, and A. M. Phillips was transferred to the Division of Fruit Insect Investigations July 1, 1941.

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2/ The writers acknowledge the assistance of members of the Division of Insecticide Investigations who supplied most of the compounds tested.

the comparatively coarse condition common to most laboratory chemicals, and, although coarse samples were always ground in a mortar to obtain finer particles, the materials used were generally much coarser than commercial insecticides. This is important in judging the results presented, because it has been shown that particle size influences the effectiveness of insecticidal materials (2, 4).

As the testing proceeded, the few outstanding compounds were easily recognized and were singled out for individual investigation. Four of these compounds have been investigated in some detail and reports published on this work-- phthalonitrile (6), 1,4-diphenylsemicarbazide (1), *p*-aminoazobenzene hydrochloride (3), and *p*-phenylazoaniline (*p*-aminoazobenzene) (7).

INSECTS TESTED

The tests described in the present paper were made on 15 species of insects which are listed below. Not all compounds were tested on all insects but, in general, more species were used with the more effective materials. The plant or foliage used with the various insects is also given, because this factor has been shown to influence the results of insecticide tests (5).

Insect	Foliage
Cabbage aphid (*Brevicoryne brassicae* (L.))	Collards
Colorado potato beetle (*Leptinotarsa decemlineata* (Say))	Potato
Cowpea weevil (*Callosobruchus maculatus* (F.))	Bean (seed)
Cross-striped cabbageworm (*Evergestis rimosalis* (Guen.))	Collards
Diamondback moth (*Plutella maculipennis* (Curt.))	Collards
Spirea aphid (*Aphis spiraecola* (Patch)	Orange
Greenhouse leaf tier (*Phlyctaenia rubigalis* (Guen.))	Collards
Hawaiian beet webworm (*Hymenia recurvalis* (F.))	Swiss chard
Imported cabbageworm (*Ascia rapae* (L.))	Collards
Melonworm (*Diaphania hyalinata* (L.))	Pumpkin and squash
Pea aphid (*Macrosiphum pisi* (Kltb.))	Pea
Rice weevil (*Sitophilus orzya* (L.))	Corn (seed)
Southern armyworm (*Prodenia eridania* (Cram.))	Collards
Southern beet webworm (*Pachyzancla bipunctalis* (F.))	Swiss chard
Squash bug (*Anasa tristis* (Deg.))	Squash

TESTS AS STOMACH INSECTICIDES

For the first test on a new material as a possible stomach insecticide, a concentration of 1 percent (8 pounds per 100 gallons)was used. Lower concentrations were used in subsequent tests on the effective compounds. Each spray was applied to 2 potted plants (6 to 8 inches high) by means of a compressed-air spray gun. When the plants were dry, 15 nearly full grown larvae were confined on each within a cylindrical screen cage, which was placed over the plant and gently forced into the soil about the inside upper edge of the pot. The cages were then placed out-of-doors in a sheltered location and examined after 2, 4, and 6 days for larval mortality and to estimate the feeding on the plants.

In these spray tests 4 compounds were used as conditioning agents, saponin and sodium lauryl sulfate at 1/4 and 1/8 pound per 100 gallons of spray, sodium monosulfonate of monobutyldiphenyl at 1 or 2 pounds per 100 gallons, and bentonite at 8 pounds per 100 gallons. These amounts have no particular significance, however, as no experiments were made to determine the most satisfactory concentration of these agents, other than that of saponin. Preliminary tests with this agent showed that 1/8 pound per 100 gallons produced a satisfactory spray in most cases. In work of this kind probably no one agent can be selected which will give optimum results with all the compounds because of the variation of the physical properties of each agent. Only small quantities of spray were made, usually by grinding the compound in a mortar with the agent and gradually diluting with water to the required concentration.

Table 1 reports the results of screen-cage tests on 97 of the more promising compounds, and on derris and lead arsenate as standards for comparison. Although the status of a few compounds is somewhat obscure because of limited testing, only 4 materials in the table would appear to be equal to, or better than, derris or lead arsenate. The outstanding compounds are 1,4-diphenylsemicarbazide (1) and phthalonitrile (6). Pentabromophenol and barium antimonyl tartrate were above the average in effectiveness. It should be added that, although phenol and cresol compounds were in general very toxic, their tendency to cause severe injury to foliage eliminates most of them from consideration. In general, of the compounds in table 1, the following 18 compounds were sufficiently effective to warrant further investigations as stomach insecticides:

2-Acetamidofluorene
Acetone semicarbazone
p-Aminoazobenzene
p-Aminoazobenzene hydrochloride
Antimonyl pyrogallol
Barium antimonyl tartrate
p-Chlorobenzenesulfonamide
Diazoaminobenzene
2,4-Dinitrophenyl acetate
1,4-Dinitrosopiperazine
1,4-Diphenylsemicarbazide
2-Fluorylamine
Hexachlorophenol
Pentabromophenol
Phenazine
Phthalonitrile
Tris(p-aminophenyl)carbinol
Xanthydrol

Sixteen others were very effective on a few species, but this specificity greatly limited their importance as insecticides.

Of the compounds listed, 6 are shown in table 6 to be very injurious to foliage, and are thus eliminated from further investigation as stomach insecticides. These are 2,4-dinitrophenyl acetate, hexachlorophenol, pentabromophenol, phenazine, tris(p-aminophenyl)carbinol, and xanthydrol. The antimony compounds and p-chlorobenzenesulfonamide were not tested for foliage injury.

The 53 compounds that were found to be relatively ineffective as stomach insecticides are shown in table 2.

FUMIGATION TESTS

Two types of fumigation tests were made. The test in petri dishes was conducted by placing a leaf section and 10 larvae in each of 2 or 3 petri dishes together with a quantity of the sample, into the top of each dish. This permitted volatilization of the compound within the dish, but prevented contact between the insects and the solid insecticide. This type of fumigation test was used only against leaf-eating insects.

Compounds found to be toxic in petri dishes were further tested as fumigants against cowpea weevil and rice weevils in special fumigation jars. The standard jar was a half-pint fruit jar with a screw cap, but larger jars were sometimes used with the more toxic materials. Each screw cap had a hole fitted with a sleeve of 3/8-inch brass tubing through which a perforated tube containing 25 insects could be inserted. With these jars the fumigant could first be volatilized by heat or allowed to stand until evaporated, and the insects inserted when desired, thus eliminating the usual loss of time caused by a gradual build-up in the concentration.

Table 3 gives the results of the tests on 51 compounds that were found to have appreciable fumigating action. Of these compounds 17 were effective against at least several species of lepidopterous larvae, and the following 8 were effective against most of the species on which they were tried:

- _p_-Dibromobenzene
- 2,5-Dichloroaniline
- Indole
- _o_-Nitrochlorobenzene
- _p_-Nitrochlorobenzene
- 4-Nitrodiphenylamine
- _p_-Thiocyanochlorobenzene
- 2,6-Xylenol

Best results were obtained with _p_-thiocyanochlorobenzene, which appeared to be somewhat more effective than the standard fumigant _p_-dichlorobenzene. Most of the other materials were either less toxic or less volatile than this standard insecticide and were not considered promising as fumigants. Many organic compounds displaying fumigating action under these conditions are unsuitable for commercial use, because they lack the volatility for a rapid build-up to the desired concentration. Certain of these compounds may be effective as contact insecticides, however, inasmuch as rapid or complete volatility is not essential in this case.

Ninety compounds tested as fumigants were relatively ineffective against all species of insects on which they were tested, and are listed alphabetically in table 4.

CONTACT TESTS

In the tests to determine the effectiveness of materials as contact insecticides, they were applied as sprays containing 8 or 4 pounds of the compound and ½ pound of saponin per 100 gallons of water. In tests against aphids the sprays were applied to infested plants, but in other cases only the insects were treated. For the pea aphid, small potted plants infested with 50 to 100 grown nymphs were sprayed, placed in glass jars, and covered with cheesecloth caps. Field infestations on collard plants were used for the tests on the cabbage aphid, samples of 100 aphids being counted in each test. For the spirea aphid, heavily infested orange twigs were cut and sprayed and then placed in flasks of water in glass jars for observation, 100 aphids being used in each test. Squash bugs, 20 per test, were dipped into the spray suspension and then transferred to small screen cages with a very small squash as food. Tests on lepidopterous insects were made by placing 15 larvae on a sheet of absorbent paper and spraying thoroughly with a compressed-air gun. The larvae were then transferred to foliage in a ventilated cage.

Contact tests were made on 22 compounds (table 5), including those showing fumigating action in the tests reported in table 3. Of the 8 effective fumigants only 4 were tested for contact action, and these were not found effective. Nine of the compounds tested were effective against aphids, and alpha, beta-dibromo-beta-nitroethylbenzene, 2,4-dinitrophenyl acetate, and o-nitroaniline were effective against the pea aphid at both concentrations. None of the compounds were very effective against the other insects. Nicotine sulfate was much more toxic than any of the other compounds tested.

PHYTOTOXICITY TESTS

The phytotoxicity tests were made on small field plots of certain truck crops. Sprays prepared at concentrations of 8 or 4 pounds per 100 gallons were applied to 4 to 20 plants with a hand-type air sprayer. Most of the tests reported were made on the basis of a single application, but in later work two applications at 10-day intervals were used as a standard precedure. To eliminate the possibility that rainfall might effect the results, the sprayed plants were covered at night and during showers.

Of the 35 compounds tested (table 6), approximately 17 were found unsafe for use on foliage, causing moderate to severe injury on two or more of the plants used. It is possible that certain compounds nontoxic to the plants tested might be toxic to other host plants. Different results may also be expected from the same host plants under other environmental conditions.

Of the 18 compounds found to be most effective as stomach insecticides (table 1), 15 were tested for foliage injury. Of these compounds 6 were too injurious to foliage for further investigations.

SUMMARY

Results of subsequent testing of 213 synthetic organic compounds found promising as insecticides in preliminary tests are presented. Ninety-seven out of 150 compounds were effective when applied as sprays to potted plants, which were then fed to certain leaf-eating insects in screen cages. In these tests the following 18 compounds were shown to be worthy of further investigation as stomach insecticides:

2-Acetamidofluorence
Acetone semicarbazone
p-Aminoazobenzene
p-Aminoazobenzene hydrochloride
Antimonyl pyrogallol
Barium antimonyl tartrate
p-Chlorobenzenesulfonamide
Diazoaminobenzene
2,4-Dinitrophenyl acetate
1,4-Dinitrosopiperazine
1,4-Diphenylsemicarbazide
2-Fluorylamine
Hexachlorophenol
Pentabromophenol
Phenazine
Phthalonitrile
Tris(*p*-aminophenyl)carbinol
Xanthydrol

Results are also presented on fumigation tests of 141 compounds. Eight of these were found to be toxic to most of the insects used, but only *p*-thiocyanochlorobenzene was more effective than *p*-dichlorobenzene.

Twenty-two compounds were applied to insects as contact sprays, but no outstanding insecticides were found. Nine of the compounds were effective against aphids, but only three were sufficiently toxic to kill the pea aphid at spray concentrations of 4 and 8 pounds per 100 gallons, which are considerably stronger than an effective nicotine spray.

Of 35 compounds tested for toxicity to plant foliage, approximately half severely injured certain tender truck crops and were thus unsuitable for use as stomach insecticides on foliage.

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Table 1.--Results with the more promising synthetic organic compounds tested as stomach insecticides when applied as sprays to potted plants and fed to nearly full-grown larvae in screen cages. Concentration 8 pounds per 100 gallons unless otherwise indicated

Compound	Insect	Host plant	Feeding in 6 days	Kill after- 2 days	Kill after- 6 days
				Percent	Percent
Standard insecticides:					
Derris, rotenone 4.5%	Cross-striped cabbageworm	Collards	Trace	83	100
				83 [2]	100
	Hawaiian beet webworm	Swiss chard	do.	22	69
				11 [2]	68
	Imported cabbageworm	Collards	do.	82 [2]	94
	Melonworm	Pumpkin	do.	30	95
				23 [2]	98
Lead arsenate	Greenhouse leaf tier	Collards	Trace	67	100
	Southern armyworm	do.	do.	71	100
				63 [2]	99
	Southern beet webworm	Swiss chard	do.	10	49
				5 [2]	63
2-Acetamidofluorene $C_6H_4CH_2C_6H_3NHCOCH_3$	Melonworm	Squash	Moderate	16	100
		Pumpkin	do.	15 [2]	100
				8 [3]	97
				6 [4]	80
	Southern armyworm	Collards	Trace	0	70
Acetone semicarbazone $(CH_3)_2CNNHCONH_2$	Cross-striped cabbageworm	Collards	Moderate	100	100
	Greenhouse leaf tier	do.	Trace	90	100 [1]
	Hawaiian beet webworm	*Amaranthus*	Moderate	100	---
		Beet	Trace	57	---

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[1] Kill in 4 days. [2] 4 lb. per 100 gal. [3] 2 lb. per 100 gal. [4] 1 lb. per 100 gal.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
Acetone semicarbazone (Cont.) $(CH_3)_2CNNHCONH_2$	Imported cabbageworm	Collards	Normal	7	42 1/
	Melonworm	Pumpkin	Moderate	92	96
			Normal	0 2/	—
			do.	3 3/	—
	Southern armyworm	Collards	do.	7	7 1/
	Southern beet webworm	Beet	Trace	96	—
S-Acetyl-1-thiolbenzoxazole $\underbrace{OC_6H_4NC}SCOCH_3$	Hawaiian beet webworm	Beet	Normal	16	33 1/
	Melonworm	Squash	do.	17	—
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	do.	3	20 1/
p-Aminoazobenzene $C_6H_5NNC_6H_4NH_2$	Cross-striped cabbageworm	Collards	Trace	61	100
	Hawaiian beet webworm	Swiss chard	do.	43	95
	Melonworm	Pumpkin	do.	73	100
	Southern armyworm	Collards	Moderate	2	15
	Southern beet webworm	Beet	Trace	25	100
p-Aminoazobenzene hydrochloride $C_6H_5N_2C_6H_4NH_2 \cdot HCl$	Cross-striped cabbageworm	Collards	do.	64	100
	Hawaiian beet webworm	Swiss chard	do.	19	100
	Southern armyworm	Collards	Normal	0	0
	Southern beet webworm	Swiss chard	Trace	23	100
2-Amino-5-azotoluene $CH_3C_6H_4NNC_6H_3(NH_2)CH_3$	Cross-striped cabbageworm	Collards	Moderate	12	100

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
3-Aminodibenzofuran $C_6H_4OC_6H_3NH_2$	Cross-striped cabbageworm	Collards	Moderate	23	86 [1]
	Greenhouse leaf tier	do.	do.	0	3 [1]
	Hawaiian beet webworm	*Amaranthus*	do.	40	--
	Melonworm	Squash	Trace	45	93 [1]
		Pumpkin	Moderate	23 [2]	93
	Southern armyworm	Collards	Normal	0	--
	Southern beet webworm	*Amaranthus*	Moderate	60	70 [1]
4-Aminobiphenyl $C_6H_5C_6H_4NH_2$	Cross-striped cabbageworm	Collards	Normal	17	54 [1]
	Greenhouse leaf tier	do.	Moderate	0	0
	Melonworm	Pumpkin	Trace	25	--
	Southern armyworm	Collards	Normal	0	--
	Southern beet webworm	Swiss chard	Trace	22	87 [1]
p-Aminophenylammonium 2-benzothiazolyl sulfide $SC_6H_4NCSNH_3C_6H_4NH_2$	Cross-striped cabbageworm	Collards	Normal	22	48 [1]
	Melonworm	Squash	do.	0	22 [1]
	Southern armyworm	Collards	Moderate	0	0
Antimonyl pyrogallol $HOC_6H_3O(SbOH)O$	Greenhouse leaf tier	Collards	Trace	0	27
	Southern armyworm	do.	do.	77	100
Auramine $((CH_3)_2NC_6H_4)_2C{:}NH$	Cross-striped cabbageworm	Collards	Normal	30	80
	Melonworm	Pumpkin	do.	6	16 [1]
	Southern beet webworm	Swiss chard	do.	0	0

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after--	
				2 days	6 days
				Percent	Percent
Azobenzene $C_6H_5NNC_6H_5$	Hawaiian beet webworm	Beet	Normal	13	50 [1]
	Melonworm	Squash	do.	13	--
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	do.	70	90 [1]
Azoxybenzene $C_6H_5\underbrace{NON}C_6H_5$	Greenhouse leaf tier	Collards	do.	0	0
	Hawaiian beet webworm	Swiss chard	do.	0	28 [1]
	Melonworm	Pumpkin	Moderate	13	46 [1]
	Southern armyworm	Collards	do.	0	20
	Southern beet webworm	Swiss chard	Normal	6	20 [1]
Barium antimonyl tartrate $Ba((SbO)C_4H_4O_6))_2$	Greenhouse leaf tier	Collards	Trace	77	100
	Southern armyworm	do.	do.	100	100
Benzalaniline $C_6H_5CHNC_6H_5$	Cross-striped cabbageworm	Collards	Normal	12	29 [1]
	Melonworm	Pumpkin	do.	7	16 [1]
Benzalazine $C_6H_5CHNNCHC_6H_5$	Cross-striped cabbageworm	Collards	do.	18	55 [1]
	Southern armyworm	do.	do.	4	4
Benzeneazo-*m*-cresol $C_6H_5NNC_6H_3(CH_3)OH$	Melonworm	Pumpkin	Moderate	0	72
	Southern armyworm	Collards	Normal	0	--
	Southern beet webworm	Swiss chard	Moderate	0	71
Benzeneazo-*o*-cresol $C_6H_5NNC_6H_4(CH_3)OH$	Melonworm	Pumpkin	do.	53	100
			do.	20 [2]	88
		Squash	do.	33	96

Footnotes on page 8.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after—	
				2 days	6 days
				Percent	Percent
p-Chlorobenzenesulfonamide	Hawaiian beet webworm	Swiss chard	Trace	93	100
$ClC_6H_4SO_2NH_2$	Southern armyworm	Collards	do.	7	20
	Southern beet webworm	Swiss chard	do.	45	100
Cupferron	Cross-striped cabbageworm	Collards	Normal	4	80
$C_6H_5N(NO)ONH_4$	Greenhouse leaf tier	do.	Moderate	0	0
	Hawaiian beet webworm	Swiss chard	do.	0	33 [1]
	Melonworm	Squash	Normal	3	7
	Southern beet webworm	Swiss chard	Moderate	14	66
Cyclopentanone semicarbazone	Melonworm	Squash	Trace	96	--
$C_5H_8NNHCONH_2$	Southern beet webworm	Swiss chard	Normal	0	--
Diamylhydroquinone	Cross-striped cabbageworm	Cabbage	Trace	69	100
$(C_5H_{11})_2C_6H_2(OH)_2$	Hawaiian beet webworm	Beet	Moderate	31	62
	Melonworm	Squash	Normal	34	48 [1]
Diazoaminobenzene	Hawaiian beet webworm	Swiss chard	Trace	93	100
$C_6H_5N_2NHC_6H_5$	Melonworm	Pumpkin	do.	100	100
	Southern armyworm	Collards	Moderate	0	0
	Southern beet webworm	Swiss chard	Trace	90	97
4,6-Dibromo-o-cresol	Cross-striped cabbageworm	Collards	Normal	10	33 [1]
$Br_2C_6H_2(CH_3)OH$	Greenhouse leaf tier	do.	do.	0	--
	Hawaiian beet webworm	Swiss chard	do.	0	--
	Melonworm	Squash	do.	10	--
	Southern armyworm	Collards	do.	0	--

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after- 2 days	Kill after- 6 days
				Percent	Percent
2,6-Dibromo-4-nitrophenol	Melonworm	Pumpkin	Trace	100	100
$Br_2C_6H_2(NO_2)OH$	Southern armyworm	Collards	Moderate	0	17 [1]
3,4-Dichloroacetophenone	Cross-striped cabbageworm	Collards	Normal	10	33 [1]
$Cl_2C_6H_3COCH_3$	Southern beet webworm	Swiss chard	do.	18	18
2,6-Dichloro-4-nitrophenol	Greenhouse leaf tier	Collards	Moderate	0	0
$Cl_2C_6H_2(NO_2)OH$	Hawaiian beet webworm	*Amaranthus*	do.	59	--
	Melonworm	Squash	do.	97	--
	Southern armyworm	Collards	do.	0	76
	Southern beet webworm	*Amaranthus*	do.	76	--
4,6-Dinitro-*o*-cresol	Cross-striped cabbageworm	Collards	Trace	100 [3]	100
$(NO_2)_2C_6H_2(CH_3)OH$				100 [4]	100
	Hawaiian beet webworm	Beet	Normal	3 [5]	--
	Melonworm	Squash	Trace	75	--
			Normal	3 [5]	--
	Southern armyworm	Collards	do.	0 [5]	0
	Southern beet webworm	Beet	do.	10 [5]	--
4,6-Dinitro-*o*-cresyl acetate	Hawaiian beet webworm	Beet	do.	97	--
$(NO_2)_2C_6H_2(CH_3)OCOCH_3$	Melonworm	Squash	do.	48	--
	Southern beet webworm	Beet	Moderate	45	81 [1]

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[5] 1/4 lb. per 100 gal.

Other footnotes on page 8.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after— 2 days	Kill after— 6 days
				Percent	Percent
2,4-Dinitrophenol	Hawaiian beet webworm	Beet	Moderate	50	---
$(NO_2)_2C_6H_3OH$	Melonworm	Squash	Trace	93	--
	Southern beet webworm	Beet	Moderate	22	---
2,4-Dinitrophenyl acetate	Hawaiian beet webworm	Swiss chard	Trace	100	100
$CH_3CO_2C_6H_3(NO_2)_2$	Melonworm	Pumpkin	None	100	100
	Southern armyworm	Collards	Normal	0	0
	Southern beet webworm	Swiss chard	do.	12	20 1/
1,4-Dinitrosopiperazine	Cross-striped cabbageworm	Collards	Trace	53	100
$ONN(CH_2CH_2)_2NNO$	Greenhouse leaf tier	do.	do.	3	93
	Melonworm	Pumpkin	Moderate	4	58
	Southern beet webworm	Swiss chard	Trace	21	100
			Moderate	10	100
Dinitrosoresorcinol	Melonworm	Pumpkin	do.	71	100
$(NO)_2C_6H_2(OH)_2$	Southern armyworm	Collards	do.	0	0
2,4-Dinitrotoluene	Cross-striped cabbageworm	Collards	Normal	7	30
$CH_3C_6H_3(NO_2)_2$	Melonworm	Pumpkin	Moderate	6	32 1/
	Southern beet webworm	Swiss chard	Normal	5	5 1/
Biphenyl (or diphenyl)	Hawaiian beet webworm	Beet	do	0	23 1/
$C_6H_5C_6H_5$	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	do.	3	75

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
1,4-Diphenylsemicarbazide	Bean leaf roller	Bean	Trace	—	100 1/
$C_6H_5NHNHCONHC_6H_5$	Greenhouse leaf tier	Collards	do.	73	100
	Hawaiian beet webworm	Swiss chard	do.	41	100
	Imported cabbageworm	Collards	Normal	0	0
	Melonworm	Pumpkin	Moderate	22	100
	Southern armyworm	Collards	Trace	94	100
	Southern beet webworm	Swiss chard	Moderate	10	100
2-Fluorenol $C_{13}H_9OH$	Southern beet webworm	*Amaranthus*	Normal	16	33 1/
p-Fluoroacetanilide	Southern armyworm	Collards	do.	0	55
$CH_3CONHC_6H_4F$	Southern beet webworm	Swiss chard	Moderate	0	8 1/
4-Fluorobiphenyl	Cross-striped cabbageworm	Collards	Normal	24	32 1/
$C_6H_5C_6H_4F$	Hawaiian beet webworm	Beet	Moderate	0	28 1/
	Melonworm	Squash	Normal	33	33 1/
	Southern armyworm	Collards	do.	0	
	Southern beet webworm	Beet	do.	0	36 1/
2-Fluorylamine	Cross-striped cabbageworm	Collards	Moderate	80	100
$C_6H_4CH_2C_6H_3NH_2$	Hawaiian beet webworm	Beet	do.	4	15 1/
	Melonworm	Pumpkin	Trace	32	100
			Moderate	14 2/	100
	Southern armyworm	Collards	Trace	0	94
	Southern beet webworm	*Amaranthus*	Moderate	40	96

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Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
2-Furaldehyde semicarbazone $(C_4H_3O)CHNNHCONH_2$	Melonworm	Pumpkin	Trace	86	100
2-Furanacrylamide $(C_4H_3O)CONH_2$	Melonworm	Pumpkin	Moderate	86	86 1/
alpha-Furfuraldoxime $(C_4H_3O)CH(NOH)$	Cross-striped cabbageworm	Collards	Normal	3	37 1/
	Hawaiian beet webworm	Swiss chard	do.	3	---
	Melonworm	Squash	do.	0	---
2-Heptanone semicarbazone $CH_3(CH_2)_4C(CH_3)NNHCONH_2$	Hawaiian beet webworm	Swiss chard	Moderate	0	82
Hexachlorophenol C_6Cl_6O	Cross-striped cabbageworm	Cabbage	Trace	88	98 1/
	Greenhouse leaf tier	Collards	Moderate	0	0
	Hawaiian beet webworm	Beet	do.	62	79 1/
	Melonworm	Squash	None	100	---
		Pumpkin	Trace	100 2/	---
				100 3/	--
			Moderate	39 4/	71 1/
	Southern armyworm	Collards	Trace	97	100 1/
	Southern beet webworm	Beet	do.	96	
Hydrazobenzene $C_6H_5NHNHC_6H_5$	Hawaiian beet webworm	Beet	Normal	6	23 1/
	Melonworm	Squash	do.	15	41 1/
	Southern beet webworm	Beet	Moderate	58	97

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after-	
				2 days	6 days
				Percent	Percent
2-Iodonaphthalene $C_{10}H_7I$	Cross-striped cabbageworm	Collards	Normal	4	27 1/
	Melonworm	Squash	do.	30	51 1/
	Southern armyworm	Collards	do.	0	
	Southern beet webworm	Beet	do.	12	16 1/
Iodoxybenzene $C_6H_5IO_2$	Cross-striped cabbageworm	Collards	do.	3	16 1/
	Greenhouse leaf tier	do.	do.	0	0
	Hawaiian beet webworm	Beet	do.	8	8 1/
	Melonworm	Squash	do.	8	32 1/
	Southern armyworm	Collards	do.	4	4
	Southern beet webworm	Beet	do.	10	48 1/
N-Methyl-*p*-acetotoluide $CH_3CON(CH_3)C_6H_4CH_3$	Cross-striped cabbageworm	Collards	do.	20	55 1/
	Melonworm	Squash	do.	26	—
2-Pentanone semicarbazone $CH_3C(NNHCONH_2)C_3H_7$	Southern beet webworm	Swiss chard	do.	18	32 1/
p-Nitroacetanilide $CH_3CONHC_6H_4NO_2$	Melonworm	Pumpkin	Moderate	36	100 1/
	Southern beet webworm	Swiss chard	do.	26	67
p-Nitroaniline $NO_2C_6H_4NH_2$	Hawaiian beet webworm	Beet	Normal	0	16
	Melonworm	Squash	Trace	10	100
	Southern armyworm	Collards	Moderate	0	0
	Southern beet webworm	Swiss chard	Normal	0	0
p-Nitrobenzyl bromide $(NO_2)C_6H_4CH_2Br$	Greenhouse leaf tier	Collards	Normal	3	3 1/
	Melonworm	Squash	do.	24	—
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Swiss chard	do.	5	36 1/

Footnotes on page 8.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after— 2 days	Kill after— 6 days
				Percent	Percent
4-Nitrophenyl phenyl ether $C_6H_5OC_6H_4NO_2$	Cross-striped cabbageworm	Collards	Normal	20	33 1/
	Southern beet webworm	Swiss chard	do.	0	0
1-Nitronaphthalene $C_{10}H_7NO_2$	Cross-striped cabbageworm	Collards	do.	5	30
	Greenhouse leaf tier	do.	do.	0	0 1/
	Melonworm	Pumpkin	Trace	53	86 1/
	Southern armyworm	Collards	Normal	0	0
p-Nitrophenol $NO_2C_6H_4OH$	Melonworm	Pumpkin	Moderate	76	--
4-Nitrophthalimide $NO_2C_6H_3(CO)_2NH$	Cross-striped cabbageworm	Collards	do.	27	90
	Melonworm	Squash	Normal	2	--
9-Nitrosocarbazole $\underbrace{C_6H_4N(NO)C_6H_4}$	Melonworm	Squash	Trace	38	--
	Southern armyworm	Collards	Normal	0	0
N-Nitrosodiphenylamine $(C_6H_5)_2NNO$	Cross-striped cabbageworm	Collards	do.	8	42 1/
	Hawaiian beet webworm	Beet	do.	6	62
	Melonworm	Squash	do.	3	40
	Southern armyworm	Collards	Moderate	0	0
	Southern beet webworm	Beet	do.	17	75
N-Nitroso-N-phenylbenzylamine $C_6H_5N(NO)CH_2C_6H_5$	Cross-striped cabbageworm	Collards	Moderate	33	90
	Melonworm	Pumpkin	Trace	10	100

Footnotes on page 8.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
Pentabromophenol Br_5C_6OH	Cross-striped cabbageworm	Cabbage	Trace	100	—
	Melonworm	Pumpkin	do.	100	--
			do.	34 [2]	96
			Moderate	38 [3]	90
	Southern armyworm	Collards	do.	0	60
	Southern beet webworm	Swiss chard	Trace	77	93
Pentachlorophenol Cl_5C_6OH	Greenhouse leaf tier	Collards	Moderate	0	0
	Hawaiian beet webworm	Beet	do.	60	82
	Melonworm	Squash	Normal	29	--
	Southern armyworm	Collards	Trace	78	93
	Southern beet webworm	Beet	Moderate	51	96
Pentaerythrityl bromide $C(CH_2Br)_4$	Hawaiian beet webworm	Amaranthus	Normal	6	60
	Melonworm	Pumpkin	Moderate	55	100
	Southern armyworm	Collards	Normal	0	0
	Southern beet webworm	Amaranthus	do.	56	83
Phenazine $C_6H_4NC_6H_4N$	Hawaiian beet webworm	Swiss chard	Moderate	17	100
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Swiss chard	Trace	81	100
Phenazine oxide $C_6H_4NONC_6H_4$	Hawaiian beet webworm	Swiss chard	Trace	13	86
	Southern beet webworm	do.	Moderate	31	69
Phenothiazine + 10% 1,3-diphenylguanidine $C_6H_4NHC_6H_4S + NH:C(NHC_6H_5)_2$	Cross-striped cabbageworm	Collards	Normal	33	83
	Southern armyworm	do.	do.	0	0

Footnotes on page 8.

Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after – 2 days	Kill after – 6 days
				Percent	Percent
Phenothiazine + 10% 1,3-di-o-tolylguanidine $\underbrace{C_6H_4NHC_6H_4S} + NH{:}C(NHC_6H_4CH_3)_2$	Cross-striped cabbageworm	Collards	Normal	19	54
	Southern armyworm	do.	do.	0	0
Phenothiazine + 10% 1,1,3-triphenylguanidine $\underbrace{C_6H_4NHC_6H_4S} + NH{:}C(NHC_6H_5)N(C_6H_5)_2$	Cross-striped cabbageworm	Collards	Moderate	30	78
	Southern armyworm	do.	Normal	0	0
Phenoxathiin $\underbrace{C_6H_4OC_6H_4S}$	Hawaiian beet webworm	Beet	Moderate	38	71
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	do.	74	100
Phenoxazine $\underbrace{C_6H_4NHC_6H_4O}$	Hawaiian beet webworm	Beet	Normal	0	14 [1]
	Melonworm	Squash	Moderate	6	—
	Southern armyworm	Collards	Normal	0	0
	Southern beet webworm	Beet	do.	10	85
p-Phenylene-bis(ammonium-2-benzothiazolyl sulfide) $(\underbrace{SC_6H_4N}CSNH_3)_2C_6H_4$	Melonworm	Squash	Moderate	0	0
	Southern armyworm	Collards	do.	0	50
p-Phenylenediamine $NH_2C_6H_4NH_2$	Greenhouse leaf tier	Collards	do.	7	7 [1]
	Hawaiian beet webworm	Beet	do.	3	86
	Melonworm	Squash	do.	21	84 [1]
	Southern beet webworm	Amaranthus	Trace	21	91 [1]

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Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
Phenyl ester of p-chlorobenzenesulfonic acid $C_6H_5OSO_2C_6H_4Cl$	Melonworm	Pumpkin	Normal	3	16 1/
	Southern beet webworm	Swiss chard	Moderate	3	90
				32	50
beta-Phenylhydrazide of phenylazoformic acid $C_6H_5NNCONHNHC_6H_5$	Greenhouse leaf tier	Collards	do.	0	0
	Melonworm	Pumpkin	do.	32	43 1/
1-Phenylsemicarbazide $C_6H_5NHNHCONH_2$	Greenhouse leaf tier	Collards	do.	0	0
	Hawaiian beet webworm	Swiss chard	Normal	9	60
	Melonworm	Squash	do.	0	—
	Southern beet webworm	Swiss chard	Moderate	43	90
Phthalonitrile $C_6H_4(CN)_2$	Hawaiian beet webworm	Swiss chard	Trace	71	100
	Imported cabbageworm	Collards	do.	30	93
	Melonworm	Pumpkin	do.	59	100
	Southern armyworm	Collards	do.	0	73
	Southern beet webworm	Swiss chard	do.	93	100
Saponin from Madhuca latifolia or Mowrah meal	Cross-striped cabbageworm	Collards	Moderate	23	98
	Southern armyworm	do.	Normal	0	--
N-Sodium-N-chloro-p-toluenesulfonamide $CH_3C_6H_4SO_2NClNa$	Cross-striped cabbageworm	Collards	Normal	3	17 1/
	Melonworm	Pumpkin	Moderate	0	32 1/
Tetrabromo-o-cresol $Br_4C_6(OH)CH_3$	Melonworm	Pumpkin	Trace	92	100
	Southern armyworm	Collards	Moderate	0	0
	Southern beet webworm	Swiss chard	do.	21	79

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Table 1.—(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after - 2 days	Kill after - 6 days
				Percent	Percent
Thiocoumarin $C_6H_4CHCHC(S)O$	Cross-striped cabbageworm	Collards	Moderate	46	99 1/
	Greenhouse leaf tier	do.	Trace	0	7 1/
	Hawaiian beet webworm	Beet	Moderate	16	68 1/
	Melonworm	Squash	do.	22	56 1/
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	Trace	83	96 1/
p-Thiocyanoiodobenzene IC_6H_4SCN	Greenhouse leaf tier	Collards	Moderate	0	0
	Melonworm	Squash	Normal	16	—
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Amaranthus	do.	41	47 1/
Methyl thio-2-naphthyl ether $C_{10}H_7SCH_3$	Melonworm	Pumpkin	do.	7	53 1/
N-p-Tolyl-p-toluene-sulfonamide $CH_3C_6H_4SO_2NHC_6H_4CH_3$	Cross-striped cabbageworm	Collards	Moderate	10	97
2,4,6-Triiodophenol $I_3C_6H_2OH$	Melonworm	Pumpkin	do.	35	100
	Southern armyworm	Collards	Normal	0	0
2,4,6-Trinitro-m-cresol $(NO_2)_3C_6H(CH_3)OH$	Cross-striped cabbageworm	Cabbage	Moderate	86	100
	Greenhouse leaf tier	Collards	do.	0	0
	Hawaiian beet webworm	Beet	Normal	6	43 1/
	Melonworm	Squash	do.	8	—
	Southern armyworm	Collards	do.	0	0
	Southern beet webworm	Beet	do.	33	90 1/

Footnotes on page 8.

Table 1.--(Continued)

Compound	Insect	Host plant	Feeding in 6 days	Kill after-	
				2 days	2 days
				Percent	Percent
Bis(2,4,6-trinitrophenyl)-amine $((NO_2)_3C_6H_2)_2NH$	Cross-striped cabbageworm	Collards	Trace	100	—
	Southern armyworm	do.	Moderate	0	13
Tris(p-aminophenyl)carbinol $(NH_2C_6H_4)_3COH$	Greenhouse leaf tier	Collards	do.	0	87
	Melonworm	Pumpkin	Trace	14	100
	Southern armyworm	Collards	do.	27	100
Xanthydrol $\underbrace{C_6H_4CH(OH)C_6H_4O}$	Hawaiian beet webworm	Beet	do.	13	93 1/
	Melonworm	Squash	Moderate	16	69
	Southern armyworm	Collards	Trace	6	33
	Southern beet webworm	Swiss chard	do.	58	100
			do. 2/	20	50 1/
N-(2,6-Xylyl)formamide $HCONHC_6H_3(CH_3)_2$	Melonworm	Pumpkin	Moderate	23	60 1/
	Southern beet webworm	Swiss chard	do.	18	75

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Table 2.--Compounds found relatively ineffective as stomach insecticides

Compound	Insect
Aminodiphenylamine hydrochloride $C_6H_5NHC_6H_4NH_2HCl$	Greenhouse leaf tier
alpha-Anisaldoxime $CH_3OC_6H_4CHNOH$	do.
4-Benzoylmorpholine $C_6H_5CONC_4H_8O$	Southern armyworm
o-Bromoacetanilide $CH_3CONHC_6H_4Br$	Greenhouse leaf tier
p-Bromohydrazobenzene $BrC_6H_4NHNHC_6H_5$	Cross-striped cabbageworm Melonworm Southern armyworm
2-Butanone semicarbazone $C_2H_5C(NNHCONH_2)CH_3$	Melonworm Southern beet webworm
N-n-Butyl-p-toluenesulfonamide $CH_3C_6H_4SO_2NHC_4H_9$	Cross-striped cabbageworm Southern armyworm
3-Chloroacenaphthene $C_{10}H_5(CH_2)_2Cl$	do.
alpha,beta-Dibromoethylbenzene $C_6H_5CHBrCH_2Br$	do.
alpha,beta-Dibromo-beta-nitroethylbenzene $C_6H_5CHBrCH(Br)NO_2$	Cross-striped cabbageworm Greenhouse leaf tier Hawaiian beet webworm Melonworm Southern armyworm Southern beet webworm
Di-"Cellosolve" xanthogen $C_{10}H_{18}O_4S_4$	Imported cabbageworm Melonworm Southern armyworm
Diethylxanthogen $C_6H_{10}O_2S_4$	Imported cabbageworm Melonworm Southern armyworm

Table 2.—(Continued)

Compound	Insect
3,5-Diiodosalicylic acid $I_2C_6H_2(OH)COOH$	Southern armyworm Southern beet webworm
Diisoamylxanthogen $C_{12}H_{26}O_2S_4$	Southern armyworm
Dimethylxanthogen $C_4H_6O_2S_4$	do.
2,4-Dinitroanisole $CH_3OC_6H_3(NO_2)_2$	Southern beet webworm
m-Dinitrobenzene $C_6H_4(NO_2)_2$	Hawaiian beet webworm Melonworm Southern armyworm Southern beet webworm
Diphenyl ester of carbonic acid $(C_6H_5O)_2CO$	Cross-striped cabbageworm Melonworm Southern armyworm
Dixanthogen of monomethyl ether of ethylene glycol $C_8H_{14}O_4S_4$	do.
Ethyl ester of cyanoacetic acid $CNCH_2COOC_2H_5$	do.
N-(2-Fluoryl)palmitamide $C_{15}H_{31}CONHC_{13}H_9$	Greenhouse leaf tier
Heptadecyl xylyl ketone $C_{26}H_{44}O$	Southern armyworm
1-Hydroxy-2-acetonaphthone $C_{10}H_6(OH)COCH_3$	Greenhouse leaf tier Southern armyworm
2,2-Bis(hydroxymethyl)-1-butanol $(CH_2OH)_3CC_2H_5$	do.
o-Iodoacetanilide $CH_3CONHC_6H_4I$	Melonworm
p-Iodoaniline $IC_6H_4NH_2$	do. Southern armyworm

Table 2.--(Continued)

Compound	Insect
N-Methyl-m-acetotoluide $CH_3CON(CH_3)C_6H_4CH_3$	Cross-striped cabbageworm
Methyl 3-methoxy-2-naphthoate $C_{10}H_6(OCH_3)COOCH_3$	Southern armyworm
Methyl-2-naphthyl ether $C_{10}H_7OCH_3$	Cross-striped cabbageworm
1-Naphthol $C_{10}H_7OH$	Hawaiian beet webworm Melonworm Southern beet webworm
1-Naphthonitrile $C_{10}H_7CN$	Southern armyworm
o-Nitroaniline $NO_2C_6H_4NH_2$	Greenhouse leaf tier Hawaiian beet webworm Melonworm Southern armyworm Southern beet webworm
p-Nitrobenzyl chloride $(NO_2)C_6H_4CH_2Cl$	Hawaiian beet webworm Melonworm Southern armyworm Southern beet webworm
o-Nitrophenyliodochloride $(NO_2)C_6H_4ICl_2$	Greenhouse leaf tier
2-Nitroresorcinol $(NO_2)C_6H_3(OH)_2$	do. Southern armyworm Southern beet webworm
1-Phenylbenzoxazole $C_6H_4NC(C_6H_5)O$	Hawaiian beet webworm Southern armyworm
Piperazine (Hydrate) $HN(CH_2)_2NH(CH_2)_2 \cdot 6H_2O$	do.
p-Propionotoluide $C_2H_5CONHC_6H_4CH_3$	Greenhouse leaf tier Southern armyworm
Quinaldine $C_6H_4CHCHC(CH_3)N$	do.

Table 2.--(Continued)

Compound	Insect
Rhodanine $\underline{SC(S)NHCOC}H_2$	Greenhouse leaf tier Melonworm Southern armyworm
Salicylaldehyde semicarbazone $HOC_6H_4CHNHNHCONH_2$	Southern beet webworm
Sulf-glycerides of corn oil . .	Imported cabbageworm Melonworm Southern armyworm
Sulfoleic acid	Imported cabbageworm Melonworm Southern armyworm
Sulfurized coconut oil	do.
5,6,7,8-Tetrahydro-1-naphthol $\underline{C_6H_8(CH)_3C}OH$	do.
Thiopropionamide $C_2H_5CSNH_2$	do.
p-Tolylmethenyl-p,p'-bis-(N,N-dimethylaniline) $CH_3C_6H_4CH(C_6H_4N(CH_3)_2)_2$	do.
1,3,5-Tribromobenzene $C_6H_3Br_3$	Melonworm
Triphenylcarbinol $(C_6H_5)_3COH$	Southern armyworm
Xanthene $\underline{C_6H_4CH_2C_6H_4O}$	Melonworm Southern armyworm
Xanthone $\underline{C_6H_4COC_6H_4O}$	do.
Zinc *n*-amylxanthate $Zn(C_5H_{11}OCS_2)_2$	do.
Zinc isoamylxanthate $Zn(C_5H_{11}OCS_2)_2$	do.

Table 3.--Results of tests of synthetic organic compounds found to have appreciable fumigating action

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
Standard insecticide:						
p-Dichlorobenzene	Cowpea weevil	Adult	1/2-Pint jar	0.25	1	100
$C_6H_4Cl_2$	Rice weevil	do.	do.	.25	1	100
				.125	1	100
				.0156	1	100
				.0078	1	78
				.0039	1	15
Azobenzene	Colorado potato beetle	Fourth	Petri dish	.25	1	85
$C_6H_5NNC_6H_5$	Cross-striped cabbageworm	do.	do.	.25	2	6
	Melonworm	do.	do.	.25	2	0
	Southern armyworm	Sixth	do.	.25	2	0
Azoxybenzene	Cross-striped cabbageworm	Fourth	do.	.25	2	3
$C_6H_5NONC_6H_5$	Southern armyworm	First	do.	.25	2	100
	Southern beet webworm	Fifth	do.	.25	2	40
Benzalaniline	Cowpea weevil	Adult	1/2-Pint jar	.50	1	40
$C_6H_5CHNC_6H_5$	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	20
	Hawaiian beet webworm	Fifth	do.	.25	2	12
	Melonworm	Fourth	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	34
	Southern beet webworm	Fourth	Petri dish	.25	2	93
p-Bromobenzonitrile	Cross-striped cabbageworm	do.	do.	.25	2	100
BrC_6H_4CN	Melonworm	do.	do.	.25	2	100
	Southern armyworm	do.	do.	.25	2	33
	Southern beet webworm	Fifth	do.	.25	2	100

1/ Number refers to instar.

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Table 3.—(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
2-Bromofluorene $C_6H_4CH_2C_6H_3Br$	Cross-striped cabbageworm	Fourth	Petri dish	0.25	2	100
p-Bromoiodobenzene BrC_6H_4I	Colorado potato beetle	Fourth	do.	.25	1	100
	Melonworm	do.	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	12
	Southern armyworm	Sixth	Petri dish	.25	2	70
2-Bromonaphthalene $C_{10}H_7Br$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	47
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Melonworm	do.	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	33
	Southern armyworm	Fourth	Petri dish	.25	2	17
	Southern beet webworm	Fifth	do.	.25	2	100
n-Butyl sulfone $(C_4H_9)_2SO_2$	Colorado potato beetle	Fourth	do.	.25	1	35
p-Chloroiodobenzene ClC_6H_4I	do.	do.	do.	.25	1	100
	Melonworm	do.	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	70
	Southern armyworm	Sixth	Petri dish	.25	2	100
2-Chloronaphthalene $C_{10}H_7Cl$	Melonworm	Fourth	do.	.25	2	100
p-Chloronitrobenzene $ClC_6H_4NO_2$	Southern armyworm	Sixth	do.	.25	2	100

Table 3.—(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
p-Cyclohexylphenol $C_6H_{11}C_6H_4OH$	Colorado potato beetle	Fourth	Petri dish	0.25	1	100
Diazoaminobenzene $C_6H_5N_2NHC_6H_5$	do.	do.	do.	.25	1	60
	Melonworm	Fifth	do.	.25	2	0
	Southern armyworm	do.	do.	.25	2	0
p-Dibromobenzene BrC_6H_4Br	Colorado potato beetle	Fourth	do.	.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	11
	Rice weevil	do.	do.	.25	1	100
	Southern armyworm	Sixth	Petri dish	.25	2	100
4,6-Dibromo-o-cresol $Br_2C_6H_2(CH_3)OH$	Colorado potato beetle	Fourth	do.	.25	1	100
	Cross-striped cabbageworm	do.	do.	.25	2	16
	Greenhouse leaf tier	Fifth	do.	.25	2	0
	Southern armyworm	Fourth	do.	.25	2	37
alpha,beta-Dibromo-ethylbenzene $C_6H_5CHBrCH_2Br$	Cowpea weevil	Adult	1/2-Pint jar	.50	1	23
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	85
	Hawaiian beet webworm	Fifth	do.	.25	2	32
	Rice weevil	Adult	1/2-Pint jar	.25	1	14
	Southern armyworm	First	Petri dish	.25	2	100
	Southern beet webworm	Fifth	do.	.25	2	28
2,6-Dibromo-4-nitrophenol $Br_2C_6H_2(NO_2)OH$	Diamondback moth	Fourth	do.	.25	2	80
	Greenhouse leaf tier	Fifth	do.	.25	2	0

Table 3.—(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
2,5-Dichloroaniline $Cl_2C_6H_3NH_2$	Colorado potato beetle	Fourth	Petri dish	0.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Diamondback moth	do.	do.	.25	2	100
	Greenhouse leaf tier	Fifth	do.	.25	2	97
	Melonworm	Fourth	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	92
				.0156	1	2
				.0312	1	46
				.125	1	80
				.0625	1	74
	Southern armyworm	Sixth	Petri jar	.25	2	100
4,4'-Difluorobiphenyl $FC_6H_4C_6H_4F$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	30
	Southern armyworm	Fourth	Petri dish	.25	2	77
Biphenyl (or diphenyl) $C_6H_5C_6H_5$	Cowpea weevil	Adult	1/2-Pint jar	.50	1	57
	Hawaiian beet webworm	Fifth	Petri dish	.25	2	16
	Rice weevil	Adult	1/2-Pint jar	.25	1	41
	Southern armyworm	Sixth	Petri dish	.25	2	30
	Southern beet webworm	Fourth	do.	.25	2	97
9-Fluorenone $\underbrace{C_6H_4COC_6}H_4$	Cowpea weevil	Adult	1/2-Pint jar	.50	1	28
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	46
	Melonworm	do.	do.	.25	2	80
	Rice weevil	Adult	1/2-Pint jar	.25	1	20
	Southern beet webworm	Fifth	Petri dish	.25	2	92

Table 3.—(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
beta-Furfuraldoxime $(C_4H_3O)CH(NOH)$	Cross-striped cabbageworm	Fourth	Petri dish	0.25	2	60
Hexachloroethane C_2Cl_6	Southern armyworm	Sixth	do.	.25	2	100
Hexachlorophenol C_6Cl_6O	Diamondback moth	Fourth	do.	.25	2	100
	Greenhouse leaf tier	Fifth	do.	.25	2	0
	Southern armyworm	Sixth	do.	.25	2	0
Hydrazobenzene $C_6H_5NHNHC_6H_5$	Colorado potato beetle	Fourth	do.	.25	1	85
	Southern armyworm	Sixth	do.	.25	2	0
Indole $\underline{C_6H_4CHCHNH}$	Colorado potato beetle	Fourth	do.	.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	81
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	100
	Southern armyworm	Fourth	Petri dish	.25	2	100
o-Iodoaniline $IC_6H_4NH_2$	Colorado potato beetle	Fourth	do.	.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Melonworm	do.	do.	.25	2	94
	Rice weevil	Adult	1/2-Pint jar	.25	1	8
	Southern armyworm	Fourth	Petri dish	.25	2	100
2-Iodonaphthalene $C_{10}H_7I$	Cowpea weevil	Adult	1/2-Pint jar	.50	1	52
	Melonworm	Fourth	Petri dish	.25	2	60
	Rice weevil	Adult	1/2-Pint jar	.25	1	55

Table 3.--(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
o-Iodonitrobenzene $IC_6H_4NO_2$	Cowpea weevil	Adult	1/2-Pint jar	0.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Diamondback moth	do.	do.	.25	2	100
	Greenhouse leaf tier	Fifth	do.	.25	2	0
o-Iodosonitrobenzene $C_6H_4(NO_2)IO$	Cowpea weevil	Adult	1/2-Pint jar	.50	1	21
	Hawaiian beet webworm	Fifth	Petri dish	.25	2	40
	Rice weevil	Adult	1/2-Pint jar	.25	1	98
2-Methylanthraquinone $C_6H_4COC_6H_3(CH_3)CO$	Colorado potato beetle	Fourth	Petri dish	.25	1	55
p-Nitrobenzyl chloride $(NO_2)C_6H_4CH_2Cl$	Rice weevil	Adult	1/2-Pint jar	.25	1	98
o-Nitrobromobenzene $BrC_6H_4NO_2$	Colorado potato beetle	Fourth	Petri dish	.25	1	100
	Diamondback moth	do.	do.	.25	2	100
	Greenhouse leaf tier	Fifth	do.	.25	2	100
	Southern armyworm	Sixth	do.	.25	2	100
p-Nitrobromobenzene $BrC_6H_4NO_2$	Cross-striped cabbageworm	Fourth	do.	.25	2	25
	Hawaiian beet webworm	Fifth	do.	.25	2	100
	Melonworm	do.	do.	.25	2	0
	Southern beet webworm	Fourth	do.	.25	2	100
m-Nitrochlorobenzene $ClC_6H_4NO_2$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	6
	Melonworm	Fifth	Petri dish	.25	2	100
	Southern armyworm	Sixth	do.	.25	2	100

Table 3.—(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
o-Nitrochlorobenzene $ClC_6H_4NO_2$	Cross-striped cabbageworm	Fourth	Petri dish	0.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	100
	Southern armyworm	Sixth	Petri dish	.25	2	100
p-Nitrochlorobenzene $ClC_6H_4NO_2$	Colorado potato beetle	Fourth	do.	.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Southern armyworm	Sixth	do.	.25	2	83
4-Nitrodiphenylamine $C_6H_5NHC_6H_4NO_2$	Colorado potato beetle	Fourth	do.	.25	1	95
m-Nitroiodobenzene $IC_6H_4NO_2$	do.	do.	do.	.25	1	100
	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Hawaiian beet webworm	Fifth	do.	.25	2	80
	Rice weevil	Adult	1/2-Pint jar	.25	1	100
				.0039	1	34
				.0156	1	46
				.0625	1	78
	Southern beet webworm	Fourth	Petri dish	.25	2	100
o-Nitroiodobenzene $IC_6H_4NO_2$	Melonworm	Fifth	do.	.25	2	100
	Southern armyworm	Sixth	do.	.25	2	37
m-Nitrophenyliodo-chloride $(NO_2)C_6H_4ICl_2$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	0
	Hawaiian beet webworm	Fifth	Petri dish	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	60

Table 3.--(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
o-Nitrophenyliodochloride $(NO_2)C_6H_4ICl_2$	Cowpea weevil	Adult	1/2-Pint jar	0.25	1	12
	Hawaiian beet webworm	Fifth	Petri dish	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	100
2-Nitroresorcinol $(NO_2)C_6H_3(OH)_2$	Greenhouse leaf tier	Fifth	Petri dish	.25	2	0
	Southern armyworm	Fourth	do.	.25	2	0
	Southern beet webworm	do.	do.	.25	2	72
Pentaerythrityl bromide $C(CH_2Br)_4$	Cross-striped cabbageworm	Third	do.	.25	2	38
	Southern armyworm	Fourth	do.	.25	2	0
p-Phenylenediamine $NH_2C_6H_4NH_2$	Diamond-back moth	do.	do.	.25	2	27
	Greenhouse leaf tier	Fifth	do.	.25	2	0
N-Phenyl-1-naphthylamine $C_{10}H_7NHC_6H_5$	Colorado potato beetle	Fourth	do.	.25	1	90
	Melonworm	do.	do.	.25	2	0
m-Thiocresol $CH_3C_6H_4SH$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	100
p-Thiocyanobromobenzene BrC_6H_4SCN	Southern armyworm	Fourth	Petri dish	.25	2	100

Table 3.--(Continued)

Compound	Insect	Stage 1/	Fumatorium	Dosage	Exposure	Mortality
				Grams	Days	Percent
p-Thiocyanochlorobenzene ClC_6H_4SCN	Cowpea weevil	Adult	1/2-Pint jar	0.25	1	100
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Diamondback moth	do.	do.	.25	2	100
	Greenhouse leaf tier	Fifth	do.	.25	2	67
	Rice weevil	Adult	1/2-Pint jar	.25	1	100
				.125	1	100
				.0078	1	100
				.0009	1	92
	Southern armyworm	Fifth	Petri dish	.25	2	100
1,3,5-Tribromobenzene $C_6H_3Br_3$	Melonworm	Fourth	do.	.25	2	56
2,6-Xylenol $(CH_3)_2C_6H_3OH$	Cowpea weevil	Adult	1/2-Pint jar	.25	1	100
	Cross-striped cabbageworm	Fourth	Petri dish	.25	2	100
	Hawaiian beet webworm	Fifth	do.	.25	2	100
	Rice weevil	Adult	1/2-Pint jar	.25	1	95
				.0156	1	100
				.0078	1	80
				.0039	1	26
				.0009	1	22
	Southern beet webworm	Fourth	Petri dish	.25	2	100

Table 4 --Compounds found relatively ineffective as fumigants

Compound	Insect	Stage 1/
Acetone semicarbazone $(CH_3)_2CNNHCONH_2$	Diamondback moth	Fourth
	Greenhouse leaf tier	Fifth
3-Acetoxy-2-naphthoic acid $CH_3COOC_{10}H_6COOH$	Southern armyworm	First
p-Aminoazobenzene $C_6H_5NNC_6H_4NH_2$	Cross-striped cabbageworm	Fourth
	Melonworm	do.
	Southern armyworm	do.
p-Aminoazobenzene hydrochloride $C_6H_5N_2C_6H_4NH_2.HCl$	Cross-striped cabbageworm	do.
	Southern armyworm	do.
3-Aminodibenzofuran $\underbrace{C_6H_4OC}C_6H_3NH_2$	Greenhouse leaf tier	Fifth
	Southern armyworm	Sixth
4-Aminobiphenyl $C_6H_5C_6H_4NH_2$	Greenhouse leaf tier	Fifth
	Southern armyworm	Fourth
Aminodiphenylamine hydrochloride $(C_6H_5)_2NH.HCl$	Greenhouse leaf tier	Fifth
alpha-Anisaldoxime $CH_3OC_6H_4CHNOH$	Cross-striped cabbageworm	Fourth
	Southern armyworm	First
Antimonyl pyrogallol $HO\underbrace{C_6H_3O(SbOH)O}$	Melonworm	Fourth
Arsenic ethyl xanthate $As(C_2H_5OCS_2)_3$	Southern armyworm	First
Barium antimonyl tartrate $Ba[(SbO)C_4H_4O_6]_2$	Melonworm	Fourth
Benzalazine $C_6H_5CHNNCHC_6H_5$	Cross-striped cabbageworm	Third
	Melonworm	Fourth
	Southern armyworm	do.

1/ Number refers to instar.

Table 4--(Continued)

Compound	Insect	Stage 1/
Benzopinacol $(C_6H_5)_2C(OH)C(OH)(C_6H_5)_2$	Southern armyworm	First
p-Bromobenzenesulfonamide $BrC_6H_4SO_2NH_2$	do.	Sixth
p-Bromobenzenesulfonanilide $BrC_6H_4SO_2NHC_6H_5$	Colorado potato beetle	Fourth
p-Bromohydrazobenzene $BrC_6H_4NHNHC_6H_5$	Southern armyworm	do.
N-(p-Bromophenylsulfonyl) morpholine $BrC_6H_4SO_2N(CH_2CH_2)_2O$	Colorado potato beetle	do.
o-Chloroacetanilide $CH_3CONHC_6H_4Cl$	Melonworm	do.
p-Chloroacetanilide $CH_3CONHC_6H_4Cl$	Southern armyworm	do.
p-Chlorobenzenesulfonamide $ClC_6H_4SO_2NH_2$	do.	do.
Cupferron $C_6H_5N(NO)ONH_4$	Greenhouse leaf tier	Fifth
Cyclohexanone semicarbazone $C_6H_{10}NNHCONH_2$	Hawaiian beet webworm	do.
N-Cyclohexylpyromucamide $(C_4H_3O)CONHC_6H_{11}$	Melonworm	Fourth
alpha,beta-Dibromo-beta-nitroethylbenzene $C_6H_5CHBrCH(Br)NO_2$	Cross-striped cabbageworm Southern armyworm	do. do.
3,4-Dichloroacetophenone $Cl_2C_6H_3COCH_3$	Melonworm	do.

Table 4 --(Continued)

Compound	Insect	Stage 1/
2,7-Dichlorofluorene $Cl\underline{C_6H_3CH_2}C_6H_3Cl$	Southern armyworm	First
Dichloramine-T $CH_3C_6H_4SO_2NCl_2$	do.	do.
2,6-Dichloro-4-nitrophenol $Cl_2C_6H_2(NO_2)OH$	Greenhouse leaf tier	Fifth
	Southern armyworm	Fourth
	Southern beet webworm	do.
4,6-Dinitro-o-cresol $(NO_2)_2C_6H_2(CH_3)OH$	Colorado potato beetle	do.
	Diamondback moth	do.
	Greenhouse leaf tier	Fifth
	Melonworm	Fourth
	Southern armyworm	Sixth
4,6-Dinitro-o-cresyl acetate $(NO_2)_2C_6H_2(CH_3)OCOCH_3$	Hawaiian beet webworm	Fifth
	Melonworm	Fourth
	Southern beet webworm	do.
Dinitro-o-cyclohexylphenol $C_6H_{11}C_6N_2(NO_2)_2OH$	Southern armyworm	Sixth
1,8-Dinitronaphthalene $NO_2C_{10}H_6NO_2$	do.	First
2,4-Dinitrophenol $(NO_2)_2C_6H_3OH$	Diamondback moth	Fourth
	Greenhouse leaf tier	Fifth
	Southern armyworm	First
2,4-Dinitrophenyl acetate $CH_3CO_2C_6H_3(NO_2)_2$	do.	Fourth
2,4-Dinitro-6-phenylphenol $C_6H_5C_6H_2(NO_2)_2OH$	do.	Sixth
1,4-Dinitrosopiperazine $ONN(CH_2CH_2)_2NNO$	Colorado potato beetle	Fourth
	Greenhouse leaf tier	Fifth
2,4-Dinitrotoluene $CH_3C_6H_3(NO_2)_2$	Colorado potato beetle	Fourth

Table 4 --(Continued)

Compound	Insect	Stage 1/
1,4-Diphenylsemicarbazide $C_6H_5NHNHCONHC_6H_5$	Greenhouse leaf tier Imported cabbageworm Melonworm Southern armyworm Southern beet webworm	Fifth do. Fourth do. Fifth
Disulfurous acid, pentaerythritol, ester of $[OS(OCH_2)_2]_2C$	Colorado potato beetle	Fourth
Dithiooxamide $NH_2C(S)C(S)NH_2$	do.	do.
Fluorene $\underline{C_6H_4CH_2C}_6H_4$	Southern armyworm	Sixth
4-Fluorobiphenyl $C_6H_5C_6H_4F$	do.	Fourth
2-Fluorylamine $\underline{C_6H_4CH_2C}_6H_3NH_2$	do.	do.
N-(2-Fluoryl)palmitamide $C_{15}H_{31}CONHC_{13}H_9$	Greenhouse leaf tier	Fifth
p-Formotoluide $HCONHC_6H_4CH_3$	Greenhouse leaf tier Southern armyworm	do. Fourth
2-Furaldehyde semicarbazone $(C_4H_3O)CHNNHCONH_2$	Melonworm	do.
2-Furanacrylamide $(C_4H_3O)CONH_2$	do.	do.
2-Heptanone semicarbazone $CH_3(CH_2)_4C(CH_3)NNHCONH_2$	Hawaiian beet webworm	Fifth
1-Hydroxy-2-acetonaphthone $C_{10}H_6(OH)COCH_3$	Greenhouse leaf tier Southern armyworm	do. Fourth

Table 4 —(Continued)

Compound	Insect	Stage 1/
3-Hydroxy-2-naphthoic acid $C_{10}H_6(OH)COOH$	Cross-striped cabbageworm Southern armyworm	Fourth First
o-Iodoacetanilide $CH_3CONHC_6H_4I$	Colorado potato beetle	Fourth
2-Iodofluorene $\underline{C_6H_4CH_2C}_6H_3I$	Southern armyworm	First
4-Methoxyacridone $\underline{C_6H_4COC_6H_3(OCH_3)NH}$	do.	do.
N-Methyl-*m*-acetotoluide $CH_3CON(CH_3)C_6H_4CH_3$	Colorado potato beetle	Fourth
Methyl-2-naphthyl ether $C_{10}H_7OCH_3$	do. Cross-striped cabbageworm	do. do.
1-Naphthylisothiocyanate $C_{10}H_7NCS$	Colorado potato beetle	do.
p-Nitrobenzyl bromide $(NO_2)C_6H_4CH_2Br$	Greenhouse leaf tier Southern armyworm	Fifth Fourth
p-Nitroiodosobenzene $(NO_2)C_6H_4IO$	do.	do.
p-Nitroiodosobenzene acetate $(NO_2)C_6H_4I(OCOCH_3)_2$	Melonworm	do.
1-Nitronaphthalene $C_{10}H_7NO_2$	Cross-striped cabbageworm Southern armyworm	do. Sixth
1-Nitro-2-naphthylamine $C_{10}H_6(NO_2)NH_2$	Southern armyworm	Fourth
N-Nitrosodibenzylamine $C_6H_5CH_2N(NO)CH_2C_6H_5$	Colorado potato beetle	do.

Table 4 --(Continued)

Compound	Insect	Stage 1/
N-Nitrosodiphenylamine $(C_6H_5)_2NNO$	Cross-striped cabbageworm Southern armyworm	Fourth do.
N-Nitroso-N-phenylbenzylamine $C_6H_5N(NO)CH_2C_6H_5$	Colorado potato beetle	do.
beta-Nitrosostyrene $C_6H_5CHCHNO$	Southern armyworm	Sixth
Pentabromophenol Br_5C_6OH	Cross-striped cabbageworm Melonworm	Fourth do.
Pentachlorophenol Cl_5C_6OH	Diamondback moth Greenhouse leaf tier Hawaiian beet webworm Southern armyworm Southern beet webworm	do. Fifth do. Sixth Fourth
Phenazine $\underline{C_6H_4NC_6H_4N}$	Cross-striped cabbageworm	do.
Phenoxathiin $\underline{C_6H_4OC_6H_4S}$	Southern armyworm	Sixth
Phenoxazine $\underline{C_6H_4NHC_6H_4O}$	do.	Fourth
Phthalonitrile $C_6H_4(CN)_2$	Hawaiian beet webworm Melonworm Southern beet webworm	Fifth Fourth do.
p-Propionotoluide $C_2H_5CONHC_6H_4CH_3$	Greenhouse leaf tier Southern armyworm	Fifth Fourth
Propyl ester of p-hydroxy-benzoic acid $HOC_6H_4COOC_3H_7$	Colorado potato beetle	do.
Rhodanine $\underline{SC(S)NHCOC}H_2$	Greenhouse leaf tier Southern armyworm	Fifth Fourth

Table 4 --(Continued)

Compound	Insect	Stage 1/
Tetrabromo-o-cresol $Br_4C_6(OH)CH_3$	Hawaiian beet webworm	Fifth
	Southern armyworm	Fourth
	Southern beet webworm	do.
2,2,6,6,-Tetramethyl-1-nitroso-4-piperidone $(CH_3)_2\underbrace{CCH_2COCH_2C(CH_3)_2N}NO$	Colorado potato beetle	do.
Thallous malonate $CH_2(COOTl)_2$	Southern armyworm	Sixth
Thioacetanilide $C_6H_5NHCSCH_3$	do.	do.
Thiocoumarin $\underbrace{C_6H_4CHCHC(S)O}$	Diamondback moth	Fourth
	Greenhouse leaf tier	Fifth
	Southern armyworm	Sixth
p-Thiocyanoiodobenzene IC_6H_4SCN	Cross-striped cabbageworm	Fourth
	Diamondback moth	do.
	Greenhouse leaf tier	Fifth
	Southern armyworm	Fourth
alpha-Thiotoluamide $C_6H_5CH_2CSNH_2$	do.	Sixth
N-p-Tolyl-p-toluenesulfonamide $CH_3C_6H_4SO_2NHC_6H_4CH_3$	Colorado potato beetle	Fourth
2,4,6-Triiodophenol $I_3C_6H_2OH$	do.	do.
	Cross-striped cabbageworm	do.
2,4,6-Trinitro-m-cresol $(NO_2)_3C_6H(CH_3)(OH)$	Diamondback moth	do.
	Greenhouse leaf tier	Fifth
Bis(2,4,6-trinitrophenyl)amine $[(NO_2)_3C_6H_2]_2NH$	Colorado potato beetle	Fourth
	Cross-striped cabbageworm	do.
1,1,3-Triphenylguanidine $HNC(NHC_6H_5)N(C_6H_5)_2$	Colorado potato beetle	do.

Table 4 —(Continued)

Compound	Insect	Stage 1/
Tris(p-aminophenyl)carbinol $(NH_2C_6H_4)_3COH$	Greenhouse leaf tier	Fifth
Xanthone $\underline{C_6H_4COC_6H_4O}$	Southern armyworm	Fourth
Xanthydrol $\underline{C_6H_4CH(OH)C_6H_4O}$	do.	do.
N-(2,6-Xylyl)formamide $HCONHC_6H_3(CH_3)_2$	Melonworm	do.

Table 5.--Results of tests of certain compounds applied as contact sprays using saponin as an emulsifying and wetting agent. Concentration 8 pounds per 100 gallons unless otherwise indicated

Compound	Insect	Stage 1/	Applied to -	Mortality	Exposure
				Percent	Days
Standard insecticide					
Derris, rotenone 4.5%	Hawaiian beet webworm	Fifth	Insect only	40	2
	Southern armyworm	Fourth	do.	50	2
Nicotine sulfate 40% 2/	Cabbage aphid	Mixed	Infested plant	100	2
	Pea aphid	Large	do.	100	1
	Squash bug	Second	Insect only	46	1
Benzalaniline	Cabbage aphid	Mixed	Infested plant	98	2
	Hawaiian beet webworm	Fifth	Insect only	0	1
	Pea aphid	Large	Infested plant	80	1
	Squash bug	Second	Insect only	15	1
p-Bromoiodobenzene	Hawaiian beet webworm	Fifth	do.	0	1
	Pea aphid	Large	Infested plant	0	1
	Southern armyworm	Fifth	Insect only	6	1
	Squash bug	Second	do.	20	1
2-Bromonaphthalene	Cabbage aphid	Mixed	Infested plant	100	2
	Hawaiian beet webworm	Fifth	Insect only	0	1
	Pea aphid	Large	Infested plant	87	1
	Southern armyworm	Fourth	Insect only	0	2
	Squash bug	Second	do.	25	1

1/ Number refers to instar or nymphal stage.

2/ 1:400 by volume.

Table 5.—(Continued)

Compound	Insect	Stage 1/	Applied to –	Mortality	Exposure
				Percent	Days
p-Chloroiodobenzene	Hawaiian beet webworm	Fifth	Insect only	3/ 0	1
	Pea aphid	Large	Infested plant	91	1
				3/ 16	1
	Southern armyworm	Fifth	Insect only	3/ 6	1
	Squash bug	Second	do.	30	1
2-Chloronaphthalene	Hawaiian beet webworm	Fifth	Insect only	0	1
	Pea aphid	Large	Infested plant	75	1
	Squash bug	Second	Insect only	0	1
p-Dibromobenzene	Cabbage aphid	Mixed	Infested plant	100	2
	Hawaiian beet webworm	Fifth	Insect only	6	1
	Pea aphid	Large	Infested plant	24	1
	Squash bug	Second	Insect only	0	1
4,6-Dibromo-*o*-cresol	Cabbage aphid	Mixed	Infested plant	100	2
	Hawaiian beet webworm	Fifth	Insect only	0	1
	Pea aphid	Large	Infested plant	85	1
				3/ 35	1
	Southern armyworm	Fifth	Insect only	0	1
	Squash bug	Second	do.	13	1
alpha,beta-Dibromoethylbenzene	Cabbage aphid	Mixed	Infested plant	100	2
	Hawaiian beet webworm	Fifth	Insect only	0	1
	Pea aphid	Large	Infested plant	50	1
	Southern armyworm	Fifth	Insect only	0	1
	Squash bug	Second	do.	68	1

3/ Concentration of insecticide, 4 pounds per 100 gallons.

Table 5--(Continued)

Compound	Insect	Stage [1]	Applied to -	Mortality	Exposure
				Percent	Days
alpha,beta-Dibromo-beta-nitroethylbenzene	Hawaiian beet webworm	Fifth	Insect only	[3] 0	1
	Pea aphid	Large	Infested plant	93	1
				[3] 96	1
	Squash bug	Second	Insect only	26	1
2,6-Dibromo-4-nitrophenol	Hawaiian beet webworm	Fifth	do.	0	1
	Southern armyworm	do.	do.	0	1
2,5-Dichloroaniline	Gabbage aphid	Mixed	Infested plant	70	2
	Spirea aphid	Large	do.	0	2
	Hawaiian beet webworm	Fourth	Insect only	0	2
	Pea aphid	Large	Infested plant	22	1
	Southern armyworm	Fourth	Insect only	0	2
	Squash bug	Second	do.	0	1
4,6-Dinitro-o-cresol	Spirea aphid	Large	Infested plant	100	1
	Hawaiian beet webworm	Fourth	Insect only	0	2
	Pea aphid	Large	Infested plant	100	1
	Southern armyworm	Fourth	Insect only	0	2
	Southern beet webworm	do.	do.	20	2
	Squash bug	Second	do.	73	1
2,4-Dinitrophenyl acetate	Hawaiian beet webworm	Fifth	Insect only	[3] 0	1
	Pea aphid	Large	Infested plant	94	1
				[3] 100	1
	Squash bug	Second	Insect only	46	1
2-Iodonaphthalene	Hawaiian beet webworm	Fifth	Insect only	0	1
	Southern armyworm	do.	do.	0	1

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Table 5.—(Continued)

Compound	Insect	Stage 1/	Applied to –	Mortality	Exposure
				Percent	Days
o-Iodonitrobenzene	Hawaiian beet webworm	Fifth	Insect only	3/ 0	1
	Pea aphid	Large	Infested plant	85	1
				3/ 40	1
	Squash bug	Second	Insect only	13	1
o-Nitroaniline	Hawaiian beet webworm	Fifth	do.	3/ 6	1
	Pea aphid	Large	Infested plant	100	1
				3/ 90	1
	Squash bug	Second	Insect only	6	1
p-Nitrobenzyl bromide	Hawaiian beet webworm	Fifth	do.	0	1
	Pea aphid	Large	Infested plant	30	1
	Southern armyworm	Fifth	Insect only	0	1
	Squash bug	Second	do.	0	1
o-Nitrobromobenzene	Spirea aphid	Large	Infested plant	0	2
	Hawaiian beet webworm	Fourth	Insect only	10	2
	Imported cabbage worm	Fifth	do.	30	2
	Pea aphid	Large	Infested plant	12	1
	Southern armyworm	Fourth	Insect only	10	2
	Squash bug	Second	do.	16	1
p-Nitrobromobenzene	Cabbage aphid	Mixed	Infested plant	5	2
	Hawaiian beet webworm	Fifth	Insect only	6	1
	Pea aphid	Large	Infested plant	86	1
	Southern armyworm	Fourth	Insect only	6	2
	Squash bug	Second	do.	5	1

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Table 5.—(Continued)

Compound	Insect	Stage 1/	Applied to -	Mortality	Exposure
				Percent	Days
o-Nitrochlorobenzene	Spirea aphid	Large	Infested plant	0	2
	Hawaiian beet webworm	Fourth	Insect only	10	2
	Imported cabbage worm	Fifth	do.	30	2
	Pea aphid	Large	Infested plant	0	1
	Southern armyworm	Fourth	Insect only	0	2
	Squash bug	Second	do.	0	1
Phthalonitrile	Spirea aphid	Large	Infested plant	0	2
	Hawaiian beet webworm	Fourth	Insect only	0	2
	Pea aphid	Large	Infested plant	0	1
	Southern armyworm	Fourth	Insect only	0	2
	Southern beet webworm	do.	do.	30	2
	Squash bug	Second	do.	46	1
2,6-Xylenol	Cabbage aphid	Mixed	Infested plant	100	2
	Pea aphid	Large	do.	5	1
	Squash bug	Second	Insect only	0	1

Footnotes on page 46 and 47.

Table 6.—Results of phytotoxicity tests of various compounds applied as sprays to small field plots. Concentration of compound 8 pounds per 100 gallons unless otherwise indicated

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
Standard insecticide: Lead arsenate	Sodium monosulfonate of monobutyldiphenyl	2-1/2	Bean	Slight	5
			Collards	None	5
			Swiss chard	Dead spots	2
			Beet	None	5
			Pumpkin	do.	5
2-Acetamidofluorene	do.	2-1/2	Bean	do.	7
			Collards	do.	7
			Beet	do.	7
			Swiss chard	do.	7
			Pumpkin	Slight	4
Acetone semicarbazone	Dried blood albumin	1/4	Bean	Moderate to severe	2
			Collards	None	5
			Squash	do.	10
			Beet	do.	10
			Potato	do.	10
p-Aminoazobenzene hydrochloride	Bentonite	8	Bean	do.	10
			Collards	do.	10
			Squash	Leaves slightly curled	10
			Beet	None	10
			Potato	do.	10

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
3-Aminodibenzofuran	Bentonite	8	Cabbage	None	9
			Beet	Moderate discoloration	4
			Bean	Slight discoloration	9
			Squash	Severe	4
			Tomato	do.	4
			Potato	Moderate	4
Azobenzene	Dried blood albumin	3/4	Potato	None	10
			Bean	do.	10
	Sodium lauryl sulfate	1/2	Squash	do.	10
			Eggplant	do.	10
			Beet	do.	10
			Tomato	do.	10
			Collards	do.	10
4-Bromobiphenyl 1/	Sulfonated castor oil	8	Bean	Severe	1
			Collards	do.	1
Diazoaminobenzene	Dried blood albumin	3/4	Potato	do.	5
	do.	3/4	Bean	Slight	5
	Sodium lauryl sulfate	1/2	Squash	do.	10
			Eggplant	do.	10
			Beet	None	10
			Collards	Yellow spots	10
			Pepper	None	10

1/ Four pounds per 100 gallons.

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
2,6-Dibromo-4-nitrophenol	Saponin	1	Bean	Very severe	1
			Collards	do.	1
			Squash	Killed	1
			Swiss chard	do.	1
2,6-Dichloro-4-nitrophenol	Bentonite	4	Bean	do.	2
			Collards	do.	2
			Beet	do.	2
			Swiss chard	do.	2
			Pumpkin	do.	2
4,6-Dinitro-o-cresol	Sodium lauryl sulfate	1/4	Bean	Very severe	1
			Collards	do.	1
2,4-Dinitrophenol	do.	1/4	Bean	Killed	2
			Cucumber	do.	2
			Cabbage	do.	2
			Potato	Leaves killed	1
2,4-Dinitrophenyl acetate	Sodium monosulfonate of monobutyl diphenyl	8	Bean	Killed	4
			Collards	do.	4
			Swiss chard	do.	4
			Pumpkin	do.	4
2,4-Dinitro-6-phenylphenol	Sodium lauryl sulfate	1/4	Bean	Severe	1
			Collards	do.	1

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
1,4-Dinitrosopiperazine	Bentonite	8	Bean	Moderate to severe	9
			Squash	None	9
			Tomato	do.	9
			Cabbage	do.	9
			Beet	do.	9
			Potato	do.	9
1,4-Diphenylsemicarbazide	do.	8	Bean	do.	32
			Potato	do.	32
			Squash	do.	32
			Tomato	do.	32
			Beet	do.	32
			Collards	Slight	32
2-Fluorenol 1/	Sodium lauryl sulfate	1/4	Bean	None	5
2-Fluorylamine	Bentonite	8	Cabbage	None	9
			Beet	do.	9
			Tomato	do.	9
			Potato	Discoloration	9
			Squash	None	4
			Bean	Discoloration	9
Hexachlorophenol	Sodium lauryl sulfate	1/4	Bean	Moderate	6
			Collards	do.	6

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
p-Nitroaniline	Saponin	1	Bean	None	7
			Collards	Severe	6
			Swiss chard	do.	6
			Squash	do.	6
p-Nitrobenzyl bromide 1/	Sodium lauryl sulfate	1/4	Bean	None	5
p-Nitrobromobenzene	do.	1/4	Bean	do.	5
			Collards	do.	5
p-Nitrophenol 1/	Sodium lauryl sulfate	1/4	Bean	Killed	1
N-Nitrosodiphenylamine 1/	do.	1/4	do.	None	5
N-Nitroso-N-phenylbenzylamine	Saponin	1	Bean	do.	29
			Swiss chard	Slight	6
			Collards	Chlorosis	6
			Squash	Slight	6
Pentabromophenol	Bentonite	4	Bean	Moderate	5
			Collards	None	5
			Swiss chard	Dead spots	5
			Beet	None	5
			Pumpkin	Severe	5

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
Pentachlorophenol	Sodium lauryl sulfate	1/4	Bean	Very severe	1
			Collards	do.	1
	Saponin	1	Squash	Killed	1
			Swiss chard	do.	1
Pentaerythrityl bromide	do.	1	Bean	None	21
			Swiss chard	do.	21
			Collards	do.	21
			Squash	Moderate	6
Phenazine	Sodium monosulfonate of monobutyl diphenyl	2-1/2	Bean	Killed	2
			Collards	Very severe	4
			Beet	Moderate	4
			Swiss chard	Killed old leaves	2
			Pumpkin	Killed	4
p-Phenylenediamine	Dried blood albumin	1/4	Bean	Severe	2
			Collards	do.	2
			Squash	do.	2
			Beet	do.	2
			Potato	do.	2
Phthalonitrile	Bentonite	8	Bean	None	24
			Collards	do.	24
			Tomato	do.	24
			Potato	do.	24
			Squash	do.	24
			Beet	do.	24

Table 6.—(Continued)

Insecticide	Accessory material		Plant sprayed	Injury	Time after spraying
		Lb. per 100 gal.			Days
Tetrabromo-*o*-cresol	Saponin	1	Bean	do.	21
			Collards	do.	21
			Squash	do.	21
			Swiss chard	do.	21
Thiocoumarin	Sodium lauryl sulfate	1/4	Bean	Severe	6
			Collards	do.	6
	Dried blood albumin	1/4	Bean	do.	2
			Collards	None	10
			Squash	Moderate	2
			Beet	do.	2
			Potato	Severe	2
p-Thiocyanobromobenzene	Sodium lauryl sulfate	1/4	Bean	Leaves killed	1
			Collards	do.	1
Tris(*p*-aminophenyl) carbinol	Saponin	1	Collards	None	10
			Swiss chard	Severe	3
			Squash	Slight	3
Xanthydrol	Bentonite	8	Bean	Severe	2
			Squash	do.	2
			Potato	do.	2
			Beet	Spot burn	10
			Collards	Moderate to severe	3

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